From quantumness to classicality: A Bohmian journey

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Traditionally it has been common to assume that the classical world smoothly arises as a particular limit of quantum mechanics (e.g., gradually changing a control parameter, such as a given quantum number). Over the last years, however, decoherence has helped to reshape the landscape of our understanding of the quantum-to-classical transition. The study of large and complex systems by means of more and more sophisticated techniques has shown that a smooth, gradual transition is true only at a statistical level. This is because even in such situations quantum coherence constitutes a fundamental element that cannot be neglected in many systems of interest. But, what's exactly quantum coherence? Although from a formal viewpoint this concept seems to be clear (just consider the off-diagonal terms of the density matrix, for example), at a physical level it is rather ambiguous in spite of its key role in quantum-to-classical transitions.

This communication turns around the concept of quantum coherence, which is analysed and discussed by means of the hydrodynamic language of the Bohmian formulation of quantum mechanics. This choice is not by chance: this formulation becomes especially suitable within this context, because it provides an unambiguous picture of the flow of quantum information (and, hence, coherence) from/to the system of interest. The discussion will cover (in as much as possible) topics such as the meaning of quantum and classical system, quantum-classical correspondence, the semiclassical approach, decoherence and emergence of classicality (classical-like behaviours), or effective dissipative models.